I. INTRODUCTION AND BACKGROUND

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This report is the result of research done by a group of students at the University of California, Berkeley, during the winter and spring quarters of 1978. These students, undergraduates majoring in environmental studies, have undertaken the project Solid Waste Management for Resource Conservation and Recovery in the San Francisco Bay as a senior seminar topic.

Why was the topic of solid waste chosen? Because it is a major environmental problem which is often overlooked. It is a problem that is growing every year and which threatens to bury the unwary American public under a self-made mountain of trash.

Solid waste can be defined as anything of solid nature that is discarded because it is no longer desirable to its owner. Table 1 shows a breakdown of the composition by sources of several categories of Bay Area solid waste. Table 2 is a breakdown of this waste according to biological or chemical composition. In other parts of this paper, references are made to several kinds of solid wastes. The category of garbage generally includes only those animal or vegetable wastes which occur as the result of household food preparation. Agricultural wastes include animal wastes from feed lots and farms, as well as wastes from food processing plants, such as canneries. Wastewater solids are the end products of the biological degradation of human sewage. Industrial wastes are composed of unusable end- or by-products of industry such as wood, metal, plastic scraps and chemical sludges. Commercial and business wastes include a very high percentage of paper.

Source	Percent of Total	lb/capita-day
Households	57%	5.7
Commercial and Business	19%	1.9
Industrial	11%	1.1
Demolition/Construction	3%	0.3
Miscellaneous	10%	1.0
	100%	10.0

Table 1. Source Composition
(Vesilind, 1977, p. 95)

The reasons for analyzing the composition and sources of solid waste are discussed in several places in this paper. One reason is that different types of solid waste cause different types of problems. Some decompose into harmful leachates, others take many, many years to begin to decompose at all. Also, a certain proportion of solid waste can be salvaged and reused or recycled. Identifying the sources of

solid waste is essential when trying to design programs aimed at decreasing solid waste volume.

	Percent by Weight
Garbage	12%
Refuse	
Paper	51%
Wood	3%
Cloth	9%
Garden wastes	8%
Metals	3%
Plastics	10%
Ceramics, glass	4%
	100%

Table 2. Composition of Residential, or Household Refuse
(Vesilind, 1977, pp. 95-110)

The purpose of this paper, however, is not to identify culprits or to make categories. Its purpose is twofold: 1) to provide information which, it is hoped, will assist in future updates of the Draft Environmental Management Plan (EMP) authored by the Association of Bay Area Governments (ABAG), and 2) to consolidate and explain facts and the results of recent research on the subject of solid waste for use by interested parties.

Legal mandates which prompted the ABAG plan are many and varied. They include the Federal Water Pollution Control Act Amendments of 1972, the Resource Conservation and Recovery Act of 1976, the California Solid Waste Management and Resource Recovery Act of 1972, the Planning Guidelines for the preparation of county solid waste management plans, Section 66780.5 of the California Government Code, and Senate Bill 650 of 1977 - the Litter Control, Recycling, and Resource Recovery Act (ABAG, 1978). Several of these laws are directed towards source reduction and some are the basis for financial assistance, while others are planning directives.

The reason for this upsurge of legislative interest in solid waste is partially an outgrowth of the relatively recent environmental movement which has been characterized by a concern over vanishing clean air and water resources. But more importantly, this recent interest in problems of solid waste management is a result of an awareness by public decision makers that solid waste as a problem is rapidly becoming acute.

Americans generate much more refuse than at any time in the past. In 1920, the U.S. daily per capita production of household and industrial waste was 2.75 pounds (Goldstein, 1969). By 1965, the estimate had risen to 4.5 pounds/person-day for household wastes only, and for 1975 the San Francisco Bay Area figure for household wastes was estimated at 5.7 pounds/person-day. If commercial, demolition, agricultural and industrial wastes are included, this figure for 1975 becomes a whopping

13 pounds/person-day (ABAG, 1978). When accompanied by a tripling in the San Francisco Bay Area population during the period 1920-1975, this doubling of the amount of per capita household waste takes on greater significance: there is six times as much trash generated each day, now, as there was half a century ago. If commercial, demolition, agricultural and industrial wastes are included, then there is 15 times more solid waste put out in the Bay Area each day than there was in 1925.

Modern packaging and food preservation techniques, while enabling gigantic population centers to be viable as centers for the advancement of culture, science, technology, medicine, and government, have also increased dramatically the quantity of refuse generated. The tin can, paper packaging, chemical, and glass bottling industries enable large quantities of foodstuffs to be stored, at the same time that they create serious waste disposal problems.

One might argue that trash disposal as a problem is not limited to modern Man. One principal kind of archaeological evidence from North and South American Indian populations of many hundreds of years ago is found in middens, or dump sites for discarded pottery, dishes, stone utensils and personal apparel. So, while refuse disposal sites are not reserved to modern man, the exponentially increasing worldwide population has transformed the making of modern middens into a problem that presses on valuable and limited resources: land, energy and materials.

Traditional refuse collection and disposal can be called a study in the absurd. Huge trucks, powered by declining reserves of petroleum, move unwanted, yet precious, resources to distant scarce land sites and deposit them. Many of these materials, such as paper, glass, aluminum, and ferrous metals could be recycled for considerably less energy and cost than was originally required to produce them from virgin materials.

There are alternatives to the widely practiced sanitary land filling. These can be categorized as low and high technology solutions. Collection and recycling or source separation systems are referred to as 'low technology' systems. All nine Bay Area counties have such operations (ABAG, 1978). Some are supported by EPA Technical Assistance and Training grants. Fundamental to all low technology systems are labor-intensive processes including the pre-sorting of trash into specific categories, which is done in the household, business, or institution. These materials are in some manner taken to a central point where they are further sorted, crushed, compacted, and sold to industries using recycled goods. In many cities, these recycling projects provide employment for handicapped, unskilled, young, or hard core unemployed people.

There are many types of capital-intensive, 'high technology' systems, all of which are designed to collect municipal waste in a central facility, separate out recyclable material (either by hand or mechanically), and burn the remaining fraction to sometimes produce steam or fuel oil. One system shreds garbage and produces a solid refuse derived fuel. Another makes methane gas by anaerobic digestion. Where they are operated today, these high technology systems are usually carried out by established refuse disposal companies. These plants may present, though, other environmental, financial, and technical problems. Resources are degraded because organic and paper fractions are burned, not recycled. In

the process there is the need for expensive pollution control equipment to meet federal and local emission standards. There is also the problem of disposal of the ash left over.

The possibility exists to combine low and high technology systems. But this combination involves the risk of building capital-intensive processing plants which may have to be abandoned if labor-intensive recycling catches on. The household and industrial diversion of large quantities of refuse may leave these plants with too little combustible or recyclable materials to operate.

Low technology enterprises can form the base for urban community employment, self-reliant and insulated from some outside pressures, allowing local capital to remain within the community. High technology systems tend to remove much of this capital from the originating community while providing only limited employment.

Legislation can also reduce waste at the source. Several bottle bills (those that prohibit the sale of non-returnable bottles) are examples of this type of source reduction that have proven themselves successful. Product packaging regulations, another legislative possibility, can also reduce waste volume.

This report will focus on five aspects of the solid waste issue which have been briefly discussed in this introductory section: 1) Source Reduction, 2) Resource Recovery, 3) Energy Recovery, 4) Marketing, and 5) Sociological Facets of Solid Waste Planning and Management. (This last item includes political and economic issues along with educational programs).

These five divisions are somewhat arbitrary. As in any environmental problem, the subdivisions of the problem interact in subtle ways and ignore all man-made boundaries; several sections may overlap in information. A table of contents is provided so that the reader can pinpoint specific areas of interest.

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